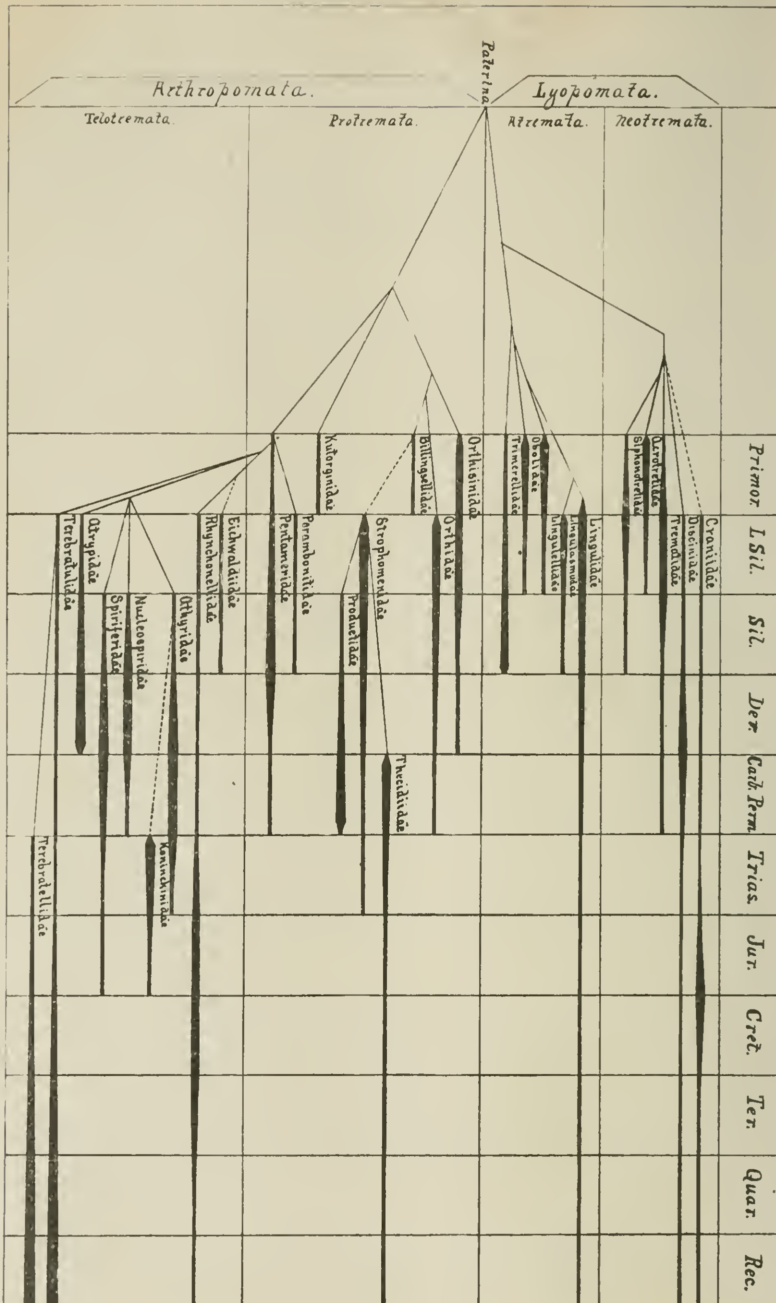
Paterina
Arthropomata.
Lyopomata.
Telotremata.
Protremata.
Atremata.
Neotremata.
Primor.
L. Sil.
Sil.
Dev.
Carb. Perm.
Trias.
Jur.
Cret.
Ter.
Quar.
Rec.
Terebratulidae
Atrypidae
Spiriferidae
Nucleospiridae
Athyridae
Rhynchonellidae
Eichwaldiidae
Pentameridae
Porambonitidae
Kutorginidae
Productidae
Strophomenidae
Billingsellidae
Orthidae
Orthisinidae
Thecidiidae
Terebratellidae
Koninckinidae
Trimerellidae
Obolidae
Lingulellidae
Lingulidae
Siphonotretidae
Acrotretidae
Trematidae
Discinidae
Craniidae

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A CLASSIFICATION OF THE BRACHIOPODA.

By Charles Schuchert, New Haven, Conn.

Plate V.

The class Brachiopoda, since 1858, has been divided by nearly all systematists into two orders, based on the absence or presence of articulating processes. These divisions were recognized by Deshayes as early as 1835, but not until twenty-three years later were the names *Lyopomata* and *Arthropomata* given them by Owen. These terms have been generally adopted by writers, though some prefer *Inarticulata* and *Articulata* of Huxley, or Bronn's *Ecardines* and *Testicardines*. Bronn,[5] in 1862, and King,[3] in 1873, while retaining these divisions, considered the presence or absence of an anal opening more important than articulating processes, and accordingly proposed the terms *Pleuropygia* and *Apygia*, and *Tretenterata* and *Clistenterata*, respectively. Many paleozoic rostrate species of *Clistenterata*, however, give evidence that an anal opening was also present, and, therefore, the absence or presence of this organ is not so persistent a character as that of a hinge.

Von Buch,[1] in 1834, also divided the class into two sections, founded on the mode of attachment. The first section contained all brachiopods fixed by a pedicle to foreign bodies, while the second is restricted to those forms in which there is no pedicle at maturity, the entire lower or ventral valve being cemented to other

objects, as in *Crania*. The first section is again divided into three groups, on the basis of the position of the pedicle, (*a*) pedicle emerging from between the valves, as in *Lingula*, (*b*) ventral valve perforated for the protrusion of the pedicle, and (*c*) uncemented shells without a pedicle opening. The third group, however, is identical with *b*, since *Leptæna*, *Productus* and *Strophomena*, genera referred to section *c*, do possess a pedicle opening. While this classification lacks a complete understanding of the features in question, it is remarkable that Von Buch, nearly sixty years ago, and Deslongchamps,[6] twenty-eight years later, recognized some of the principles upon which the classification of the Brachiopoda is now being established, viz.: the nature of the pedicle opening.

Up to 1846 the general external features of brachiopods served the majority of authors as the essential basis for generic differentiation. In that year, however, King[2] pointed out that more fundamental and constant characters exist in the interior of the shell, a fact which soon came to be generally recognized, mainly through the voluminous writings of Thomas Davidson.

In 1848, Gray,[4] probably stimulated by King's[2] paper, divided the Brachiopoda into two sub-classes, *Ancylopoda* and *Helictopoda*. These divisions rest entirely on the basis of the arm structure and the presence or absence of a calcareous support. The *Ancylopoda* are distinguished in having the "oral arms recurved and affixed to fixed appendages on the disk of the ventral [dorsal] valve," while in *Helictopoda* "they are regularly spirally twisted when at rest." The brachia, however, in all recent species, are recurved and more or less spirally enrolled, except in some geratologous forms of loop-bearing genera, as *Cistella* and *Gwynia*. Therefore *Helictopoda*, as far as the arm structure is concerned, will also include the *Ancylopoda*. In fact, to the former he referred only the terebratuloids, if *Thecidium* is excluded, while *Ancylopoda* contained all other brachiopods whether articulate or inarticulate forms. These sub-classes are further divided, on the basis of the brachia, into four orders, *Ancylobrachia*, *Cryptobrachia*, *Sclerobrachia*, and *Sarcicobrachia*. Of these the first only can be retained as a sub-order, since it includes the loop-bearing genera. The other orders have so heterogeneous an assemblage of forms as to be of no permanent value.

Beyond the introduction of new families, no further attempt

was made by writers to divide the Brachiopoda into other orders than *Lyopomata* and *Arthropomata* until 1883, when Waagen[8] published his great work on the fossils of this class from the Salt Range group of India. He found it "absolutely necessary" to further divide the *Lyopomata* and *Arthropomata* each into three suborders. The basis for these suborders has no underlying principle of general application, yet the divisions are of permanent value, for each contains an assemblage of characters not to be found in any of the others. Waagen's genealogy of the *Arthropomata*, with *Orthis* as the prototype, falls at once to the ground, since Hall[14] has recently shown that probably no true *Orthis* exists in the primordial. The orthis-like shells of the primordial are forms either with a deltidium or a spondylium (the interior spoon-shaped plate of pentameroids) or both plates present in the same individual. Ephebolic *Orthis* do not possess either structure, but during nepionic and early nealogic growth may develop a deltidium, which, before maturity is attained, is lost by abrasion or concealed by the incurvature of the ventral beak. *Lingula*, on the other hand, is usually regarded as the prototype for all brachiopods, but this is impossible, since a number of inarticulate genera flourished for ages before *Lingula* was developed.

No classification can be natural and permanent unless based on the history of the class (chronogenesis) and the ontogeny of the individual. However, as long as the structure of the early paleozoic genera remained practically unknown and the ontogeny untouched, nothing could be attempted of a permanent nature. Recently a work[14] upon paleozoic brachiopods has been published, in which many of the early genera are clearly defined, so that their structures and geologic sequence are now more accurately known. The ontogenetic study of paleozoic species was initiated two years ago by Beecher and Clarke,[11] and the results combined with those derived from the development of some recent species, and published by Kovalewsky, Morse, Shipley, Brooks and others, confirm the conclusions reached through chronogenesis. Moreover, the application by Dr. Beecher,[12, 13] of the law of morphogenesis as defined by Hyatt,[9, 10] and the recognition and establishment of certain primary characters, have resulted in the discovery of a fundamental structure of general application to the classification of these organisms. It has for its basis the nature of the pedicle opening and the stages of shell growth. On this the author has

divided the class into four orders, the *Atremata*, *Neotremata*, *Protremata* and *Telotremata*. In the *Atremata*, the pedicle passes "freely from between the two valves, the opening being more or less shared by both," while in the *Neotremata*, the pedicle opening is restricted to one valve, the ventral, "remaining open in primitive mature forms [*Trematidæ*], becoming enclosed in secondary forms during nealogic stages [*Discinidæ*], and in derived types enclosed in early nealogic or nepionic stages [*Acrotretidæ*]." In the *Protremata*, there is a deltidium (the pseudo-deltidium of authors), which, in the earliest primordial, appears to begin as a short plate covering but a small portion of the delthyrium (*Kutorgina cingulata* after Walcott, according to Beecher). This plate rapidly attains its full growth, closing the entire delthyrium of the ventral valve, as in *Clitambonites* and *Billingsella*, while in the *Orthidæ* it is developed only during nepionic or nealogic growth. The delthyrium in the *Telotremata* is without any trace of covering during nepionic growth, but during the succeeding stages there grow out from the walls of the former two plates (the deltidial plates) which usually meet medially, and may become anchylosed.

It is remarkable that three of the four types of pedicle openings should appear in the earliest known horizon of the primordial, yet fundamental structures in other classes of organisms have developed with equal rapidity. Prof. Hyatt[9] says "the acknowledged sudden appearance of the larger number of all the distinct types of invertebrata in the paleozoic, and of the greater number of all existing and fossil types before the expiration of the paleozoic time, speak strongly for the quicker evolution of forms in the paleozoic and indicate a general law of evolution. This, we think, can be formulated as follows: Types are evolved more quickly and exhibit greater structural differences between genetic groups of the same stock while still near the point of origin, than they do subsequently. The variations or differences may take place quickly in the fundamental structural characteristics, and even the embryos may become different when in the earliest period, but subsequently only more superficial structures become subject to great variations." All the fundamental structures, as the four types of pedicle openings and the various calcareous supports of the brachia, were in existence during the Trenton period of the Lower Silurian.

In tracing the four types of pedicle openings to their origin, it is found that the *Telotremata* were the last to appear, having been developed in the *Pentameridæ* of the *Protremata*. The *Atremata* gave rise to the *Neotremata* and *Protremata*. Since *Lingula* of the *Atremata* is not the prototype for the class as it passes through a paterina and obolella stage, this must be looked for in a shell not passing through more than one stage. *Paterina* is this type, being the most primitive genus known, as well as the adult form representing the embryonic shell or protegulum of other brachiopods. The *Atremata* through the *Trematidæ* gave origin to the *Neotremata*, while the *Protremata* originated in *Kutorginidæ*, which is one of the first steps from the inarticulate towards the articulate forms.

Of secondary value for classification the writer has relied on the presence or absence of a straight hinge line, internal plates, calcareous brachial supports, and reversional or geratologous development. In some families, containing chiefly rostrate forms, as in the *Pentameridæ* and *Nucleospiridæ*, there are genera with short straight hinge lines. In other families where long hinges are prevalent, rostrate examples, as in the *Orthidæ* and *Spiriferidæ*, are found. The exceptions are either specializations or reversional tendencies, and when sufficiently pronounced are regarded as of subfamily importance. Examples of geratology are present in most of the four orders, but particularly in the *Terebratellidæ*, where the *Megathyrinæ* and *Kraussininæ* have partially or entirely lost their calcareous brachial appendages.

The accompanying plate, (pl. v.) giving the apparent genesis of the families and their geological distribution, is added so that students can have before them on a single page a summary of the classification here proposed. It should be borne in mind, however, that the lines are but a graphic expression of our present information of the class, and that future study may change their arrangement.*

Dall[7] in his Index says "from the preceding list it appears that about four hundred and sixty-three generic and subgeneric names have been rightly or wrongly associated with the group of

*The names *Lingulasmiidæ* and *Orthisinidæ* should be changed to *Lingulasmatidæ* and *Clitambonitidæ*.

Brachiopoda. * * * Of all these only about one hundred and thirty have been at all generally accepted." It should be stated that many of the synonyms are errors in composition and corrections in orthography.

In the following list there are two hundred and seventy-seven valid genera or subgenera, a growth of more than twofold since the date (1877) of Dall's Index. Forty-seven families or subfamilies are here recognized, while in that list there are but eighteen.

An analysis of the table of geological distribution shows conclusively that the class attained its climax of diversity during paleozoic time. In the lower third of the primordial, the Olenellus horizon, three of the four orders are already present, while the fourth originates in the lower portion of the Lower Silurian. Not even a single suborder was introduced subsequent to the Lower Silurian. Of the forty-seven families and subfamilies constituting the class, thirty-six became differentiated in the paleozoic, and of these, twenty-seven disappeared with it, while but nine continued into the mesozoic. Of paleozoic families, six are represented by living species, viz.: *Lingulidæ*, *Disciniдæ*, *Craniidæ*, *Thecidiidæ*, *Rhynchonellidæ*, and *Terebratulidæ*.

Of the two hundred and seventy-eight genera now in use, one hundred and eighty-six had their origin in paleozoic seas, or two-thirds of the entire class, and of this great number but seven are known to pass into the mesozoic, viz.: *Lingula*, *Orbiculoidea*, *Crania*, *Spiriferina*, *Athyris*, *Terebratula*, and *Hemiptychina*. Besides these, *Cyrtina* and *Retzia* are often mentioned as occurring in the Triassic, but the species probably belong to other genera.

In the primordial, brachiopods are not numerous. They usually differ fundamentally from each other, and do not appear to have been persistent, as but four of the twenty-two genera pass into the Lower Silurian. In the Silurian and Devonian, the class is very prolific in species and genera. Of the fifty-one genera occurring in the Carboniferous but seven are known to have survived the break between the paleozoic and mesozoic. During the latter period, the spire-bearing brachiopods pass out of existence, while the great paleozoic suborder *Thecacea* is represented by a few small species of the *Thecidiidæ* which continued to be represented up to the present time. The *Terebratulidæ* had their in-

ception in the Lower Silurian, but are not a pronounced paleozoic group. However, on reaching the Jurassic and Cretaceous, the rocks fairly abound with their shells, and from that time on they are the chief representatives of the class. *Lingula* and *Crania* are present in the Lower Silurian, and as far as can be determined have persisted to the present time.

The *Atremata*, which contains the oldest and the simplest forms structurally, is represented by twenty-four genera, while the *Neotremata* and *Protremata* originating almost simultaneously from the former have thirty-one and eighty-two, respectively. The *Telotremata* had its origin in the *Neotremata*. It is the last order to appear, and has by far the greatest number of genera, one hundred and thirty-eight.

To Dr. C. E. Beecher the writer is indebted for many valuable suggestions, as well as for the careful reading of the manuscript of this paper.

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Synonyms are in brevier under the name to which they are referred.

An interrogation mark before a name indicates that the family or subordinal relation is in doubt.

BRACHIOPODA.

(Cuvier 1802), Dumeril 1806.

Spirobranchiophora, Gray 1821; Palliobranchiata, Blainville 1824; Branchiopoda, Risso 1826 (not Latreille); Brachiopodidæ, Broderip 1839; Branchionopoda, Agassiz 1847; Brachionacephala, Bronn 1862; Spirobranchia, Haeckel; Branchionobranchia, Pætel 1875.

Subclass **LYOPOMATA**, Owen 1858.

Helictopoda (part), and Sarcicobrachia (part), Gray 1848, King 1850; Pleuropygia, and Ecardines, Bronn 1862; Inarticulata, Huxley 1864; Tretenterata, King 1873.

Order **Atremata**,* Beecher 1891.

Mesokaulia, Waagen 1885.

1. Family PATERINIDÆ,† n. fam.

Paterina, Beecher 1891.

2. Family OBOLIDÆ,‡ King 1846.

Obolella, Billings 1861.
  Dicellomus, Hall 1871.
Elkania, Ford 1886.
Neobolus, Waagen 1885.
? Spondylobolus, McCoy 1852.

Obolus, Eichwald 1829.
  Ungula, Pander 1830.
  Ungulites, Bronn 1848.
  Aulonotreta, Kutorga 1848.
  Acritis, Volborth 1868.
  Schmidtia, Volborth 1869 (not Bals-Criv. 1863).

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*This order is characterized by the pedicle passing out freely between the valves, while in the NEOTREMATA it is restricted to one valve emerging through a variously modified opening.

†*Paterina*, of the lowest primordial, is the simplest shelled condition of brachiopods known. Its growth lines show that it does not pass through distinct stages of growth in the shell as do all other families of this class. Nearly all brachiopods begin their shelled existence with a paterina-like stage. The protegulum or embryonic shell, of the Brachiopoda is minute, and therefore usually not observable on mature specimens, but where well-preserved young, either fossil or recent, have been accessible it is always seen to be present. Inarticulate species or the dorsal valve of articulate forms often retain it in the mature condition. The protegulum is homologous with the protoconch of cephalopods and gastropods and the prodissoconch of pelecypods. *Paterina*, therefore, represents a form of growth common to the protegulum and nepionic stages of the majority of brachiopods.

‡The lingula-shaped shells with obolelloid interiors, the LINGULELLIDÆ, are removed from this family since it is very probable that from them developed the LINGULIDÆ. In this connection, the writer wishes to state that *Lingulella*, as here understood, is based on *L. cœlata* Hall, sp., and *L. ella* Hall and Whitfield.

The obolelloids are thicker, more calcareous, and rounder shells than the LINGULELLIDÆ, and in all probability gave origin to the TRIMERELLIDÆ.

3. Family TRIMERELLIDÆ, Davidson and King 1874.

? Lakmina, Œhlert 1887.
    Davidsonella, Waagen 1885 (not Munier-Chalmas 1880).
Dinobolus, Hall 1871.
    Conradia, Hall MS. 1862.
    Obolellina, Billings 1871.
    Ungulites, Quenstedt 1871 (not Bronn 1848).
Monomorella, Billings 1871.
Trimerella, Billings 1862.
    Gotlandia, Dall 1870.
Rhynobolus, Hall 1874.

2′. Family LINGULELLIDÆ,* n. fam.

Lingulella, Salter 1866.
Lingulepis, Hall 1863.
Leptobolus, Hall 1871.
Paterula, Barrande 1879.
    Cyclus, Barrande 1879.
?Mickwitzia, Schmidt 1888.

2″. Family LINGULIDÆ, Gray 1840.

Lingula, Bruguière 1792.
    Pharetra, Bolton 1798.
    Lingularius, Dumeril 1806.
Glossina, Phillips 1848.
Dignomia, Hall 1871.
Glottidia, Dall 1870.
Barroisella, Hall 1892.
Thomasina, Hall 1892.

3′. Family LINGULASMATIDÆ,† n. fam., Winchell and Schuchert.

Lingulops, Hall 1871.
Lingulasma, Ulrich 1889.
    Lingulelasma, Miller 1889.

Order **Neotremata**,‡ Beecher 1891.

Suborder **Daikaulia**,§ Waagen 1885.

1. Family TREMATIDÆ, n. fam.

Discinolepis, Waagen 1885.
Schizobolus, Ulrich 1886.

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*See foot-note to the OBOLIDÆ.

†The species of this family are platform-bearing lingulæ. Internally their relations are with the TRIMERELLIDÆ, but the elongate shape and strongly phosphatic nature of their shells combined with their later appearance in geologic time give strong support to the view that they have originated from another phylum, the LINGULIDÆ, rather than that which gave rise to the TRIMERELLIDÆ, the OBOLIDÆ.

‡"Pedicle fissure remaining open in primitive mature forms, becoming enclosed in secondary forms during nealogic stages, and in derived types enclosed in early nealogic or nepionic stages."

§The suborder DAIKAULIA contains the inarticulate uncemented species in which the passage for the pedicle is through one valve during all nealogic and ephebolic stages of growth. In the TREMATIDÆ is probably indicated one of the first steps from the OBOLIDÆ towards the ACROTRETIDÆ. Succeeding growth to the protegulum, in the former family, is not holoperipheral, but ceases at its straight cardinal line, leaving, posterior to the protegulum, a more or less wide triangular notch in the ventral valve. In the DISCINIDÆ, early growth is as in the TREMATIDÆ, but before maturity is attained the two sides of the pedicle passage are gradually brought together, forming a long narrow depression in the shell, at the anterior end of which the pedicle emerges. The reduction in size of the pedicle notch progressed rapidly in the ACROTRETIDÆ towards a small circular perforation. In these families, the protegulum is invariably situated at the anterior end of the pedicle passage, while in the dorsal valve it is marginal. In the SIPHONOTRETIDÆ, during younger stages of growth, the pedicle opening was probably marginal, but long before maturity is attained the opening is carried anteriorly through the protegulum and nepionic growth by resorption of the shell, while a deposition takes place posteriorly underneath the pedicle.

Trematis, Sharpe 1847.
Orbicella, d'Orbigny 1847.
Schizocrania, Hall and Whitfield 1875.
Œhlertella, Hall 1890.
Lingulodiscina, Whitfield '90.
? Monobolina, Salter 1865.

2. Family Discinidæ, Gray 1840.

Orbiculidæ, McCoy 1844.

Orbiculoidea, d'Orbigny 1847.
Schizotreta, Kutorga 1848.
Lindstrœmella, Hall 1890.
Rœmerella, Hall 1890.
Discina, Lamarck 1819.
Orbicula, Sowerby 1830 (not Cuvier 1798).
Discinisca, Dall 1871.

2'. Family Acrotretidæ, n. fam.

Iphidea, Billings 1872.
Acrothele, Linnarsson 1876.
Linnarssonia, Walcott 1885.
Discinopsis (Matthew), Hall 1892.
Acrotreta, Kutorga 1848.
Conotreta, Walcott 1889.
? Mesotreta, Kutorga 1848.
? Volborthia, von Möller 1873.

3. Family Siphonotretidæ, Kutorga 1848.

Siphonotreta, de Verneuil 1845.
Schizambon, Walcott 1884.
Schizambonia, Œhlert 1887.
? Keyserlingia, Pander 1861.
? Helmersenia, Pander 1861.

Suborder **Gasteropegmata**, Waagen 1885.

Family Craniidæ, King 1846.

Orbiculæ, Deshayes 1830; Craniadæ, Gray 1840.

Crania, Retzius 1781.
Nummulus, Stobæus 1732.
Criopus, Poli 1791.
Criopoderma, Poli 1795.
Orbicula, Cuvier 1798 (not Sowerby 1830).
Orbicularius, Dumeril 1806.
Craniolites, Schlotheim 1820.
Discina, Turton 1832 (not Lamarck 1819).
Criopododerma, Agassiz 1846.
Choniopora, Schauroth 1854.
Craniella, Œhlert 1888.
Cardinocrania, Waagen 1885.
Ancistrocrania, Dall 1877.
Cranopsis, Dall 1871 (not A. Adams).
Craniscus, Dall 1871.
Siphonaria, Quenstedt 1851 (not Sowerby).
Pholidops, Hall 1860.
Craniops, Hall 1859.
Pseudocrania, McCoy 1851.
Palæocrania, Quenstedt 1871.

Subclass **ARTHROPOMATA,** Owen 1858.

Helictopoda (part), Sarcicobrachia (part), Ancylopoda and Acylobrachia, Gray 1848; Apygia, Testicardines, Lineicardines and Denticardines, Bronn 1862; Articulata, Huxley 1864; Clistenterata, King 1873.

Order **Protremata**,* Beecher 1891.

Suborder **Trullacea**,† n. suborder.

Aphaneropegmata (part), and Productacea (part), Waagen 1883; Eleutherobranchiata (part), Neumayr 1883.

1. Family Kutorginidæ,‡ n. fam.

Kutorgina, Billings 1861. | Schizopholis, Waagen 1885.

2. Family Clitambonitidæ,§ n. fam., Winchell and Schuchert.

Orthisidæ (part), d'Orbigny 1849; Orthisinæ, Waagen 1884.

Clitambonites, Pander 1830.
Pronites, Pander 1830.
Gonambonites, Pander 1830.
Orthisina, d'Orbigny, 1847.
Polytœchia. Hall 1892.
Protorthis, Hall 1892.
Hemipronites, Pander 1830.
Scenidium, Hall 1860.
Mystrophora, Kayser 1871.

2′. Family Pentameridæ, McCoy 1844.

Hypothyridæ (part), King 1850; Pentameridæ, Hall 1867; Camerophoriinæ and Pentamerinæ, Waagen 1883; Stenochismatinæ and Conchidiinæ, Œhlert 1887.

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*Some of the oldest forms of this order have at maturity an incomplete deltidium, which rapidly attained its full development, so that in other species it covers the entire delthyrium of the ventral valve. In the Orthidæ, the deltidium is usually absent or rudimentary at maturity, but may be present in the nepionic and sometimes in early nealogic stages.

†*Trulla*, a scoop. Having reference to the spoon-shaped plate in the ventral valve ("spondylium" of Hall), to the upper surface of which were attached the adductor, ventral pedicle and divaricator muscles.

The species of this suborder are the earliest articulate forms known. In the lowest primordial, there are long-hinged and rostrate forms, having usually a spondylium and deltidium. These structures are regarded as of prime importance in classification, and species possessing them are therefore placed at the base of the Arthropomata, and are considered as ancestral forms for all articulate genera. After these parts are fully developed, the tendency, in geologic sequence, is to eliminate the spondylium, retaining the deltidium in the Thecacea, while in the Pentameridæ the reverse has usually taken place. Forms wider than long, having a spondylium and usually a deltidium, the Clitambonitidæ, became extinct with the Devonian, while the rostrate genera, in which the deltidium is commonly rudimentary or absent, persist to the close of the paleozoic age. Those forms with a deltidium and no spondylium, the Thecacea, appear to be present in the lowest primordial, but are not characteristic until the upper third is attained, and are still living in *Thecidium*. At the base of the Lower Silurian, species are developed without either of these structures, the Orthidæ, passing out of existence with the paleozoic. The Rhynchonellidæ were in all probability derived from the Pentameridæ, and from them developed almost simultaneously the Helicopegmata and Ancylobrachia.

‡The genera referred to this family have usually been placed among the Lyopomata. *Kutorgina cingulata*, Billings, the type of *Kutorgina*, as described and illustrated by Walcott (Bull. no. 30, U. S. Geol. Surv.), has more the characters of an articulate than an inarticulate brachiopod. This species has rudimentary articulating processes. Good examples of it show that the lateral walls of the ventral cardinal area are linear, increasing in width towards the line of junction of this valve with the dorsal, and it is here that the rudimentary teeth are situated. In *Schizopholis*, the rudimentary cardinal walls of *Kutorgina* are fully developed, the delthyrium is reduced to a narrow triangular fissure, which in the latter nearly occupies the entire posterior area. Beecher has also observed that *K. cingulata* has a short, perforated, deltidium in the apical portion of the ventral valve.

§This family is proposed for the long-hinged forms with spondylia, the majority of which also have a well-developed deltidium perforated for the passage of the pedicle. The Pentameridæ is restricted to the rostrate forms of essentially the same internal structure, with the deltidium usually entirely or partially obsolete in adult specimens.

Camarella (part), Billings 1859.
Anastrophia, Hall 1867.
  Brachymerus, Shaler 1865 (not Dej. 1834).
Conchidium, Linné 1760.
Pentamerus, Sowerby 1813.
  Pentastère, Blainville 1824.
  Gypidia, Dalman 1828.
Pentamerella, Hall 1867.
Gypidula, Hall 1867.
Amphigenia, Hall 1867.
Camarophoria, King 1850.
  Stenochisma, Dall 1877; Œhlert 1887 (not Conrad 1839).
Stricklandinia, Billings 1863.
  Stricklandia, Billings 1859.
Sieberella, Œhlert 1887.
Antirhynchonella, Quenstedt 1871.
Lycophoria, Lahusen 1885.

3. Family PORAMBONITIDÆ, Davidson 1853.

Porambonites, Pander 1830.
  Priambonites, Agassiz 1847.
  Isorhynchus, King 1850.

Suborder **Thecacea**.* n. suborder.

Aphaneropegmata (part), Productacea, Coralliopsida, and Kampylopegmata (part), Waagen 1883; Eleutherobranchiata (part), Neumayr 1883; Cryptobrachia (part), Gray 1848.

Family BILLINGSELLIDÆ,† n. fam.

Billingsella, Hall 1892.

Family STROPHOMENIDÆ, King 1846.

Subfamily ORTHOTHETINÆ, Waagen 1884.

Strophomeninæ (part), Waagen 1884.

? Orthidium, Hall 1892.
Strophomena, Blainville 1825.
  Hemipronites, Meek 1872 (not Pander 1830).
Kayserella, Hall 1892.
Derbya, Waagen 1884.
Meekella, White and St. John 1870.

*Theca, a cover. Having reference to the deltidium of one piece covering the delthyrium or triangular fissure in the apical portion of the ventral valve. The THECACEA differ chiefly from the TRULLACEA, from which they were derived, in being without the complete internal spoon or spondylium. See note to TRULLACEA.

†Those primordial species essentially orthoid in structure, but with a large deltidium and a more or less complete chilidium, have been referred to *Billingsella* by Hall. The writer is of the impression that *Billingsella* or some closely allied genus gave origin to the ORTHIDÆ, and that the former were derived from some species also having, in addition to the above mentioned characters, a spondylium, or essentially a *Clitambonites*. The progression towards *Orthis* from *Clitambonites* appears to have been in first eliminating the spondylium by attaching it to the bottom of the ventral valve, thus forming the dental plates and the somewhat elevated muscular area of *Billingsella*. The next step is to remove the deltidium and chilidium and to develop a more pronounced cardinal process to produce an *Orthis*. This is the course of development in geologic sequence. In *Orthis deflecta* Conrad. sp., there is a deltidium, which in some individuals is large and in others covers but one-half the delthyrium. In mature *O. tricenaria* Conrad and *O. pectinella* Emmons, of the Trenton formation, there is present a small convex deltidium and chilidium which in species of later faunas become nepionic characters and are obsolete during nealogic and ephebolic growth.

The STROPHOMENIDÆ may also have had their origin in some form related to *Billingsella*, but the data are as yet insufficient to establish clearly its line of development.

Orthothetes, Fischer de Waldh. 1837.

Orthis, King 1850 (not Dalman 1828).

Hipparionyx, Vanuxem 1843.

Streptorhynchus, King 1850.

? ? Badiotella, Bittner 1890.

Triplecia, Hall 1859.

Dicraniscus, Meek 1872.

Mimulus, Barrande 1879.

Streptis, Davidson 1881.

Subfamily RAFINESQUINÆ,* n. subfam.

Leptænacea, Braun 1840; Orthisidæ (part), d'Orbigny 1847; Davidsonidæ, King 1850; Strophomeninæ (part), Waagen 1884.

Rafinesquina, Hall 1892.

Leptæna, Dalman 1828.

Leptagonia, McCoy 1844.

Strophomena, Meek 1873 (not Blainville 1825).

Plectambonites, Œhlert 1887 (not Pander 1830).

Stropheodonta, Hall 1850.

Brachyprion, Shaler 1865.

Douvillina, Œhlert 1887.

Leptostrophia, Hall 1892.

Pholidostrophia, Hall 1892.

Strophonella, Hall 1879.

Amphistrophia, Hall 1892.

Leptella, Hall 1892.

Plectambonites, Pander 1830.

Leptæna, Davidson 1853; Œhlert 1877 (not Dalman 1828).

Tropidoleptus, Hall 1859.

? Vitulina, Hall 1861.

Leptænisca, Beecher 1890.

Christiania, Hall 1892.

Davidsonia, Bouchard 1847.

Subfamily CADOMELLINÆ, Munier-Chalmas 1887.

Cadomella, Munier-Chalmas 1887.

Family THECIDIIDÆ,† Gray 1840.

Subfamily THECIDIINÆ, Dall 1870.

Thecidium, Sowerby 1824.

Thecidia, Defrance 1822.

Lacazella, M.-Chalmas 1880.

Thecidiopsis, M.-Chalmas 1887.

Thecidella, M.-Chalmas 1887.

Eudesella, M.-Chalmas 1880.

Pterophloios, Gümbel 1861.

Bactrynium, Emmerich 1855. (In error. Not Bactrillium, Herr.)

Davidsonella, M.-Chalmas 1880.

*The relative form of the valves in this subfamily, with one exception, *Strophonella*, is the reverse of that in the ORTHOTHETINÆ. The valves are nearly always one convex (ventral), the other concave (dorsal), causing the visceral cavity to be very shallow. The cardinal process is also somewhat differently constructed.

†The THECIDIIDÆ usually are placed with or near the TEREBRATULIDÆ. Beecher has shown (Amer. Jour. Sci., vol. XLIV, p. 141, 1892) that their affinities are with the strophomenoids. There are no calcareous brachial supports nor deltidial plates in *Thecidium*, as are more or less completely developed in all terebratuloids. The characteristic markings of the dorsal valve are homologous with those in *Leptænisca*, *Davidsonia*, and the so-called "reniform markings" of the PRODUCTIDÆ.

Subfamily Lyttoniinæ, Waagen 1883.

Lyttonia, Waagen 1883.
  Leptodus, Kayser 1882.
Oldhamina, Waagen 1883.

Family Productidæ, Gray 1840.

Productina, Giebel 1846; Chonetinæ and Productinæ, Waagen 1884.

Chonetes, Fischer de Waldh. 1837.
  Leptæna, McCoy 1844 (not Dalman 1828).
Anoplia, Hall 1892.
Chonetella, Waagen 1884.
Chonostrophia, Hall 1892.
Chonetina, Krotow 1888.
  Chonetella, Krotow 1884 (not Waagen 1884).
Daviesiella, Waagen 1884.
Productella, Hall 1867.
Productus, Sowerby 1812.
  Pyxis, Chemnitz 1784.
  Producta, G. B. Sowerby 1825.
  Arbusculites, Murray 1831.
  Protonia, Linck 1830 (not Rafinesque).
  Marginifera, Waagen 1884.
Proboscidella, Œhlert 1887.
Etheridgina, Œhlert 1887.
Chonopectus, Hall 1892.
Strophalosia, King 1844.
  Orthothrix, Geinitz 1847.
  Leptænulosia, King 1845.
Aulosteges, Helmersen 1847.
? ? Aulacorhynchus, Dittmar 1871.
  Isogramma, Meek and W. 1873.

Family Richthofenidæ, Waagen 1885.

Richthofenia, Kayser 1881.

Family Orthidæ,* Woodward 1852.

Orthisidæ (part), d'Orbigny 1847; Orthinæ and Enteletinæ, Waagen 1884.

Orthis, Dalman 1828.
  Orthambonites, Pander 1830.
  Plectorthis, Hall 1892.
  Hebertella, Hall 1892.
  Schizophoria, King 1850.
  Orthotichia, Hall 1892.
  Enteletes, Fischer de Wald. 1830.
    Syntrielasma, Meek 1865.
  Dinorthis, Hall 1892.
  Plæsiomys, Hall 1892,
  Orthostrophia, Hall 1883.
  Dalmanella, Hall 1892.
  Heterorthis, Hall 1892.
  Bilobites, Linné 1775.
    Dicœlosia, King 1850.
  Rhipidomella, Œhlert 1890.
    Rhipidomys, Œhlert 1887 (not Wagner.)
  Platystrophia, King 1850.

*It is not intended, by placing the Orthidæ at the end of the order Protremata, to suggest an aberrant development or their derivation from the Productidæ, for it is believed that the orthoid stock had its origin in the Billingsellidæ. All orthoids are without the spondylium of the Trullacea, and cannot, therefore, be placed in that suborder, while the absence of a deltidium at maturity places the Orthidæ after those families having this plate in all stages of growth. For other observations see note to Billingsellidæ.

Order **Telotremata**,* Beecher 1891.

Kampylopegmata (part), Waagen 1883; Pegmatobranchiata (part), Neumayr 1883.

Suborder **Rostracea**,† n. suborder.

Family RHYNCHONELLIDÆ, Gray 1848.

Hypothyridæ (part), King 1850; Rhynchonellinæ, Waagen 1883.

Rhynchotrema, Hall 1860.
Rhynchotreta, Hall 1879.
Uncinulus, Bayle 1878.
Hypothyris, King 1846 (not Phillips 1841).
Stenochisma (Conrad 1839), Hall 1867.
Leiorhynchus, Hall 1860.
Rhynchoporina, Œhlert 1887.
  Rhynchopora, King 1856 (not Illiger and Latreille).
Terebratuloidea, Waagen 1883.
Acanthothyris, d'Orbigny 1850.
Norella, Bittner 1890.
Hemithyris, d'Orbigny 1847.
Peregrinella, Œhlert 1887.
Rhynchonellina, Gemmellaro 1871.
Dimerella, Zittel 1870.
Cryptopora, Jeffreys 1869.
  Atretia, Jeffreys 1876.
  Neatretia, Œhlert 1891.
Rhynchonella, Fischer de Wald. 1809.
  Oxyrhynchus, Llhwyd 1699 (not Aristotle).
  Rhyngonella, Bronn 1849.
  Bicornes, Quenstedt 1851.
  Uncinulina, Bayle 1878.
  Halorella, Bittner 1890.
  Austriella, Bittner 1890.
Eatonia, Hall 1857.
? Branconia, Cagel 1890.

?Family EICHWALDIIDÆ,‡ n. fam.

Eichwaldia, Billings 1858.
  Dictionella, Hall 1867.

*The TELOTREMATA during nepionic and early nealogic growth have an open triangular fissure or delthyrium in the apex of the ventral valve through which the pedicle emerged. In later nealogic and ephebolic growth, the fissure is more or less closed anteriorly through the development from the mantle of two plates, one from each wall of the delthyrium, which usually coalesce centrally. These plates are known as the "deltidial plates." In such forms as *Cyrtia*, *Cyrtina*, and *Syringothyris*, where the ventral cardinal area is very high, the deltidial plates are anchylosed, the mantle in this region becoming continuous and the plate growing as one piece. The TELOTREMATA, therefore, develop a covering to the delthyrium in an entirely different manner from the other orders during nealogic and ephebolic growth.

†*Rostrum*, a beak. The genera of this suborder are rostrate shells without a spondylium or any calcareous brachial supports other than short or long, straight or slightly curved, freely terminating crura. In the HELICOPEGMATA, the latter consists of two calcareous spiral lamellæ, while in the ANCYLOBRACHIA there is a loop.

‡The genus *Eichwaldia* is very peculiar in not having a distinct articulation of the valves as in other ARTHROPOMATA and further in the Siphonotreta-like pedicle opening. These characters are considered by some writers to indicate affinities with the LYOPOMATA, and it is to this subclass the genus has been doubtfully referred by authors. In *Eichwaldia* there is, however, a method by which articulation takes place consisting of narrow grooves along the lateral edges on the dorsal valve and corresponding ridges or teeth in the ventral.

The writer thinks that *Eichwaldia* had its origin either in the RHYNCHONELLIDÆ or PENTAMERIDÆ, and not directly through any inarticulate phylum; that the peculiar pedicle opening is a modification of the open or closed triangular delthyrium of rostrate species, just as the nepionic circular foramen in *Siphonotreta* becomes changed to an elongate fissure by progressing anteriorly through the shell.

Suborder **Helicopegmata**,* Waagen 1883.

Spiriferacea, Waagen 1883.

Family Atrypidæ,† Dall 1877.

Subfamily Zygospirinæ, Waagen 1883.

Anazygidæ (part), Davidson 1884.

Zygospira, Hall 1862.
- Stenocisma, Hall 1847 (not Conrad 1839; Hall 1867).
- Anazyga, Davidson 1882.
- Orthonomæa, Hall 1858.

Glassia, Davidson 1882.

Cœlospira, Hall 1863.
- Leptocœlia, Hall 1857 (not 1859).

Anoplotheca, Sandberger 1856

Subfamily Atrypinæ, Waagen 1883.

Atrypa, Dalman 1828.
- Cleiothyris, Phillips 1841 (not King 1850).
- Spirigerina, d'Orbigny 1847.

Grünewaldtia, Tschernyschew 1885.

? Karpinskya, Tsch. 1885.

Family Spiriferidæ,‡ King 1846 (emend Davidson).

Martiniinæ and Reticulariinæ, Waagen 1883; Spiriferinidæ, Davidson 1884.

1. Subfamily Suessiinæ, Waagen 1883.

Cyrtina, Davidson 1858.

Delthyris, Dalman 1828.

Spiriferina, d'Orbigny 1847.

Suessia, Deslongchamps 1854.

Mentzelia, Quenstedt 1871.

1′. Subfamily Uncitinæ, Waagen 1883.

Uncites, Defrance 1825.

2. Subfamily Trigonotretinæ, n. subfam.

Delthyrinæ (part), Waagen 1883.

Cyrtia, Dalman 1828.

Syringothyris, Winchell 1863.
- Spirifer, Meek and H. 1864.

Martinia, McCoy 1844.

Spirifer, Sowerby 1815.
- Choristites, Fischer de Wald. 1825.
- Trigonotreta, Koenig 1825; Meek and Hayden 1864.

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*The Helicopegmata are distinguished in having two calcareous, simple or double, spirally enrolled, brachial supports, which may or may not be attached to each other by a variously constructed band or "loop." The direction of the spirals, their connection with the hinge plate and the nature of the loop are considered of prime importance in classifying the genera of this suborder. External characters are not always even of generic value.

†In this family the apices of the brachia are medially or dorsally directed. The loop in the Zygospirinæ is a simple connecting band, which in adult Atrypinæ is disunited, having free ends. In the Atrypidæ and Spiriferidæ, the primary lamellæ are straight from their attachment to the crural plate to near the anterior margin, and do not recurve near their point of origin, as in the Nucleospiridæ and Athyridæ.

‡The Spiriferidæ are usually much elongated along the hinge line, have postero-laterally directed brachia joined by a V-shaped loop in the Suessiinæ and Uncitinæ, while in the Trigonotretinæ the loop is obsolescent and consists of two prongs terminating freely, one attached to each primary lamella.

Martiniopsis, Waagen 1883.
Ambocœlia, Hall 1860.
Reticularia, McCoy 1844.

Spiriferus, Blainville 1827.
Spirifera, J. de C. Sowerby 1835.
Brachythyris, McCoy 1844.
Fusella, McCoy 1844.
Hysterolithus, Quenstedt 1871.

Family NUCLEOSPIRIDÆ,* Davidson 1882.

Retziinæ and Dayinæ, Waagen 1883; Anazygidæ (part), Davidson 1884.

Dayia, Davidson 1882.
Hindella, Davidson 1882.
Nucleospira, Hall 1858.
Retzia, King 1850.
Trigeria, Bayle 1878.
Rhynchospira, Hall 1859.
Trematospira, Hall 1857.
Eumetria, Hall 1864.
? Acambona, White 1862.
? Uncinella, Waagen 1883.

Family ATHYRIDÆ,† Phillips 1841.

1. Subfamily ATHYRINÆ, Waagen 1883.

Meristina, Hall 1867.
Athyris, Davidson 1853 (not McCoy 1844).
Whitfieldia, Davidson 1882.
Bifida, Davidson 1882.
Athyris, McCoy 1844.
Actinoconchus, McCoy 1844.
Spirigera, d'Orbigny 1847.
Euthyris, Quenstedt 1871.
Anomactinella, Bittner 1890.
Cleiothyris, King 1850 (not Phillips 1841).
Seminula, McCoy 1841.
Spirigerella, Waagen 1883.
Dioristella, Bittner 1890.
Amphitomella, Bittner 1890.
Plicigera, Bittner 1890.
Tetractinella, Bittner 1890.
Pentactinella, Bittner 1890.
Kayseria, Davidson 1882.
Diplospirella, Bittner 1890.
Euractinella, Bittner 1890.
Pexidella, Bittner 1890.
Anisactinella, Bittner 1890.

1.′ Subfamily MERISTELLINÆ, Waagen 1883.

Meristella, Hall 1860.
Pentagonia, Cozzens 1846.
Goniocoelia, Hall 1861.
Charionella, Billings 1861.
Merista, Suess 1851.
Camarium, Hall 1859.
? Clorinda, Barrande 1879.

*In the NUCLEOSPIRIDÆ and ATHYRIDÆ the brachia are directed laterally. The primary lamellæ are straight but for a short distance from their point of attachment, then bending backward, recurve to form the spiral cones. In the SPIRIFERIDÆ they remain direct.

The apex of the V-shaped loop in the NUCLEOSPIRIDÆ terminates in a more or less long simple process, which may be hooked at its outer end.

†The apex of the V-shaped loop has two processes which, in the ATHYRINÆ, are first short and then become elongated to such an extent that they enter between the first and second revolution of the primary lamellæ of each cone, and in some genera continue to the apex of the brachia. In the MERISTELLINÆ, the two processes of the loop bend upon themselves, return, and join at their point of origin, thus resembling the handles of a pair of scissors.

Family Koninckinidæ, Davidson 1853.

Koninckininæ and Amphiclininæ, Waagen 1883; Diplospidæ and Diplospiridæ, Munier-Chalmas 1880.

- Koninckina, Suess 1853.
- Amphiclina, Laube 1865.
- Koninckella, M.-Chalmas 1880.
- ? Thecospira, Zugmeyer 1880.
- ? Amphiclinodonta, Bittner 1890.

Suborder **ANCYLOBRACHIA**,* Gray 1848 (Emend).

Ancylopoda and Cryptobrachia (part), Gray 1848; Kampylopegmata and Terebratulacea, Waagen 1883.

Family Terebratulidæ, Gray 1840.

Subfamily Centronellinæ, Waagen 1882.

Meganterinæ, Waagen 1882.

- Hallina, Winchell and Schuchert 1892.
- Rensselaeria, Hall 1859.
- Newberria, Hall 1891.
  - Rensselandia, Hall 1867.
- Meganteris, Suess 1856.
- Centronella, Billings 1859.
  - Cryptonella, Hall 1863 (not 1861, 1867.)
- Cryptonella, Hall (1861?) 1867.
- Juvavella, Bittner 1888.
- Nucleatula (Zugmayer) Bittner 1890.
- ? Notothyris, Waagen 1882.

Subfamily Stringocephalinæ, Dall 1870.

Stringocephalidæ, King 1850; Davidson 1853.

- Stringocephalus, Defrance 1827.
- ? Cryptocanthia, White and St. John 1868.

Subfamily Terebratulinæ, Dall 1870.

- Dielasma, King 1850.
  - Epithyris, King 1850 (not Phillips 1841).
  - Seminula, McCoy 1855 (not 1844).
- Dielasmina, Waagen 1882.
- Terebratula, Llhwyd 1699.
  - Sacculus, Llhwyd 1699.
  - Lampas, Meuschen 1787.
- Glossothyris, Douville 1880.
- Pygope, Link 1830.
  - Diphyites, Schröter 1799.
  - Pugites, de Hann 1833.
  - Antinomia, Catullo 1850.
- ? Propygope, Bittner 1890.
- Liothyrina, Œhlert 1887.
  - Epithyris, Desl. 1862 (not King 1848).

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*This suborder is characterized by having a calcareous loop for the support of the brachia. Some authors have regarded the length of the loop as of subfamily importance, but this the writer does not consider as of great value in classification. The work of Friele, Deslongchamps, Davidson, Fischer and Œhlert and others, has shown that in certain forms the loop passes through various stages of growth, or metamorphoses. In another set of genera, the Terabratulidæ, the loop does not pass through any transitional stages. Upon this basis the genera have been arranged tentatively by Dr. Beecher and the writer. However, much yet remains to be worked out regarding the loop and the dental and septal plates in the fossil forms, before any permanent classification of the genera into families is possible. Geratology has also been taken into account, as a number of genera have partially or entirely lost their brachial supports.

Terebratularius, Dumeril 1806.
Nucleata, Quenstedt 1871.
Musculus, Quenstedt 1871 (not Klein 1753.)
Hemiptychina, Waagen 1882.
Rhætina, Waagen 1882.
Zugmeyeria, Waagen 1882.
Dictyothyris, Douville 1880.
Gryphus, Megerle 1811 (not Brisson 1760).
Liothyris, Douville 1880 (not Conrad 1875).
Terebratulina, d'Orbigny 1847.
Eucalathis, Fischer and Œhlert 1890.
Agulhasia, King 1871.
Disculina, Deslongchamps 1884.

Family ? DYSCOLIIDÆ, Fischer and Œhlert 1892.

Dyscolia, Fischer and Œhlert 1890.

Family TEREBRATELLIDÆ, King (Emend Beecher 1893).

Waldheimidæ, Douville, 1880; Waldheimiinae, Waagen 1882.

Subfamily DALLININÆ, n. subf. Beecher.

Dallina, n. gen. Beecher. Type *Waldheimia septigera* Lovén.
Macandrevia, King 1859.

Lacqueus, Dall 1870.
Frenula, Dall 1871.
Ismenia, King 1850 (not Dall 1871).
Kingina, Davidson 1852.
Kingia, Schoenbach 1867.
Lyra, Cumberland 1816.
Terebrirostra, d'Orbigny 1847
Trigonosemus, Koenig 1825.
Fissurirostra, d'Orbigny 1847.
Fissirostra, d'Orbigny 1848.
Delthyridea, King 1850.
Flabellothyris, Deslong. 1884.
Eudesia, King 1850.
Orthotoma, Quenstedt 1871.
Trigonella, Quenstedt 1871.
Zeilleria, Bayle 1878.
Fimbriothyris, Deslong. 1884.
Ornithella, Deslong. 1884.
Microthyris, Deslong. 1884.
Aulacothyris, Douville 1880.
Camerothyris, Bittner 1890.
Epicyrta, Deslong. 1884.
Cincta, Quenstedt 1871.
Antiptychina, Zittel 1883.
Plesiothyris, Douville 1880.
? Hynniphoria, Suess 1858.
? Cruratula, Bittner 1890.
? Orthoidea, Friren 1875.

Subfamily, PLATIDIINÆ, Dall 1870.

Platidia, Costa 1852.
Morrisia, Davidson 1852.

Subfamily MEGATHYRINÆ, Dall 1870.

Argiopidæ, King 1850; Megathyridæ, Œhlert 1887; Argiopidæ, Davidson 1884; Argiopinæ, Davidson 1887.

Megathyris, d'Orbigny 1847.
    Argiope, Deslongchamps 1842 (not Savigny and Audouin 1827).
Cistella, Gray 1850.
Zellania, Moore 1854.
Gwynia, King 1859.

Subfamily MAGELLANINÆ, n. subf. Beecher.

Waldheimidæ (part), Douville, 1880; Terebratellinæ, Davidson.

Magellania, Bayle 1880.
    Waldheimia, King 1850 (not Brulle 1846).
Terebratella, d'Orbigny 1847.
    Delthyris, Menke 1830 (not Dalman 1828).
    Ismenia, King 1850 (not Dall 1870).
    Waltonia, Davidson 1850.
    Magasella, Dall 1870.
Neothyris, Douville 1880.
Cœnothyris, Douville 1880.

Subfamily MAGASINÆ, Davidson 1887.

Magasidæ (part), d'Orbigny 1847, King 1850; Rhynchoridæ (part), King 1850; Muhlfeldtinæ, Œhlert 1887.

Magas, Sowerby 1816.
Bouchardia, Davidson 1849.
    Pachyrhynchus, King 1850.
Muhlfeldtia, Bayle 1880.
    Megerlia, King 1850 (not Robineau Desvoidy 1830).
Mannia, Dewalque 1874.
Rhynchorinæ, Œhlert 1887.
? Rhynchora, Dalman 1828.

Subfamily KRAUSSININÆ, Dall 1870.

Kraussidæ (part). Davidson 1870.

Kraussina, Davidson 1859.
    Kraussia, Davidson 1852 (not Dana 1852).
Megerlina, Deslongchamps 1884.

GEOLOGICAL DISTRIBUTION OF THE BRACHIOPODA.

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Fam. Paterinidæ.	—										
Paterina, Beecher.	—										
Fam. Obolidæ.	—	—									
Obolella, Billings.	—										
Elkania, Ford.	—										
Neobolus, Waagen.	—										
Obolus, Eichwald.	—	—									
? Spondylobolus, McCoy.		—									
Fam. Trimerellidæ.	—	—	—								
? Lakmina, Œhlert.	—										
Dinobolus, Hall.		—	—								
Monomorella, Billings.			—								
Trimerella, Billings.			—								
Rhynobolus, Hall.			—								
Fam. Lingulellidæ.	—	—									
Lingulella, Salter.	—										
Lingulepis, Hall.	—										
Leptobolus, Hall.		—									
Paterula, Barrande.		—									
? Mickwitzia, Schmidt.	—										
Fam. Lingulidæ.		—	—	—	—	—	—	—	—	—	—
Lingula, Bruguière.		—	—	—	—	—	—	—	—	—	—
Glossina, Phillips.		—	—	—	—						
Dignomia, Hall.				—							
Glottidia, Dall.											—
Barroisella, Hall.				—							
Thomasina, Hall.		—									
Fam. Lingulasmatidæ.		—	—								
Lingulops, Hall.		—	—								
Lingulasma, Ulrich.		—									
Fam. Trematidæ.	—	—	—	—	—						
Discinolepis, Waagen.	—										
Trematis, Sharpe.		—									
Schizocrania, Hall & Whitf.		—	—	—							
Schizobolus, Ulrich.				—							
Œhlertella, Hall.					—						
? Monobolina, Salter.		—									
Fam. Discinidæ.		—	—	—	—	—	—	—	—	—	—
Orbiculoidea, d'Orbigny.		—	—	—	—	—	—	—			
Schizotreta, Kutorga.		—	—								
Lindstrœmella, Hall.				—							
Rœmerella, Hall.				—							
Discina, Lamarck.										—	—
Discinisca, Dall.										—	—
Fam. Acrotretidæ.	—	—									
Iphidea, Billings.	—										
Acrothele, Linnarsson.	—										
Linnarssonia, Walcott.	—										
Discinopsis (Matthew), Hall.	—										
Acrotreta, Kutorga.	—	—									
Conotreta, Walcott.		—									

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
? Mesotreta, Kutorga.		—									
? Volborthia, von Moller.	—										
Fam. Siphonotretidæ.	—	—	—								
Siphonotreta, de Verneuil.		—	—								
Schizambon, Walcott.	—	—									
? Keyserlingia, Pander.		—									
? Helmersenia, Pander.		—									
Fam. Craniidæ.		—	—	—	—	—	—	—	—	—	—
Crania, Retzius.		—	—	—	—	—	—	—	—	—	—
Craniella, Œhlert.		?		—							
Cardinocrania, Waagen.					—						
Ancistrocrania, Dall.								—			
Craniscus, Dall.											
Pholidops, Hall.		—	—	—			—				
Pseudocrania, McCoy.		—	—								
Fam. Kutorginidæ.	—										
Kutorgina, Billings.	—										
Schizopholis, Waagen.	—										
Fam. Clitambonitidæ.	—	—	—	—							
Clitambonites, Pander.		—									
Polytœchia, Hall.		—									
Protorthis, Hall.	—										
Hemipronites, Pander.		—									
Scenidium, Hall.		—	—	—							
Fam. Pentameridæ.	—	—	—	—	—						
Camarella (part), Billings.	—	—									
Anastrophia, Hall.		—	—								
Conchidium, Linné.			—	—							
Pentamerella, Hall.				—							
Gypidula, Hall.				—							
Amphigenia, Hall.				—							
Camarophoria, King.				—	—						
Stricklandinia, Billings.			—								
Sieberella, Œhlert.			—								
Antirhynchonella, Quenstedt.			—								
Lycophoria, Lahusen.			—								
Fam. Porambonitidæ.		—	—								
Porambonites, Pander.		—	—								
Fam. Billingsellidæ.	—		?								
Billingsella, Hall.	—										
Fam. Strophomenidæ.		—	—	—	—	—					
Subfam. Orthothetinæ.		—	—	—	—	—					
? Orthidium, Hall.		—									
Strophomena, Blainville.		—									
Orthothetes, Fischer de Waldheim.			—	—	—						
Hipparionyx, Vanuxem.				—							
Streptorhynchus, King.					—						
Kayserella, Hall.				—							
Derbya, Waagen.					—						
Meekella, White and St. John.					—						
Triplecia, Hall.		—	—								
Mimulus, Barrande.			—								
Streptis, Davidson.			—								
? ? Badiotella, Bittner.						—					

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Subfam. Rafinesquinæ.		—	—	—	—						
Rafinesquina, Hall.		—	?								
Leptæna, Dalman.		—	—	—	—						
Stropheodonta, Hall.			—	—							
Pholidostrophia, Hall.			—	—							
Strophonella, Hall.			—	—							
Leptella, Hall.		—									
Plectambonites, Pander.		—	—								
Leptænisca, Beecher.			—								
Christiania, Hall.			—								
Davidsonia, Bouchard.				—							
Tropidoleptus, Hall.				—							
? Vitulina, Hall.				—							
Subfam. Cadomellinæ.							—				
Cadomella, M.- Chalmas.							—				
Fam. Thecidiidæ.					—	—	—	—	—	—	—
Subfam. Thecidiinæ.							—	—	—	—	—
Thecidium, Sowerby.						?		—			
Lacazella, M.- Chalmas.							—	—	—	—	—
Thecidiopsis, M.- Chalmas.								—			
Thecidella, M.- Chalmas.							—				
Eudesella, M.- Chalmas.							—				
Pterophloios, Gümbel.							—				
Davidsonella, M.- Chalmas.							—				
Subfam. Lyttoniinæ.					—						
Lyttonia, Waagen.					—						
Oldhamina, Waagen.					—						
Fam. Productidæ.			—	—	—						
Chonetes, Fischer de Wald.			—	—	—						
Chonetella, Waagen.					—						
Chonostrophia, Hall.			—	—							
Chonetina, Krotow.					—						
Daviesiella, Waagen.					—						
Productella, Hall.				—							
Productus, Sowerby.					—						
Proboscidella, Œhlert.					—						
Etheridgina, Œhlert.					—						
Chonopectus, Hall.					—						
Strophalosia, King.				—	—						
Aulosteges, Helmersen.					—						
? ? Aulacorhynchus, Dittmar.					—						
Fam. Richthofenidæ.					—						
Richthofenia, Kayser.					—						
Fam. Orthidæ.		—	—	—	—						
Orthis, Dalman.		—	—								
Plectorthis, Hall.		—	—	—							
Hebertella, Hall.		—	—								
Schizophoria, King.			—	—	—						
Orthotichia, Hall.					—						
Enteletes, Fischer de Wald.					—						
Dinorthis, Hall.		—									
Plæsiomys, Hall.		—									
Orthostrophia, Hall.			—								
Dalmanella, Hall.		—	—	—							
Heterorthis, Hall.											
Bilobites, Linné.		—	—								

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Rhipidomella, Œhlert.			—	—	—						
Platystrophia, King.		—	—								
Fam. Rhynchonellidæ.	—	—	—	—	—	—	—	—	—	—	—
Rhynchotrema, Hall.		—									
Rhynchotreta, Hall.			—								
Uncinulus, Bayle.			—	—							
Hypothyris, King.				—							
Stenochisima, Conrad.				—							
Leiorhynchus, Hall.				—							
Rhynchoporina, Œhlert.					—						
Terebratuloidea. Waagen.					—						
Rhynchonella, Fischer de Wald.		?	?	?	?	—	—	—	—	—	—
Austriella. Bittner.						—	—				
Acanthothyris, d'Orbigny.							—				
Norella, Bittner.						—					
Hemithyris, d'Orbigny.										—	—
Peregrinella, Œhlert.								—			
Rhynchonellina, Gemmellaro.							—				
Dimerella. Zittel.						—					
Cryptopora, Jeffreys.											—
Eatonia, Hall.			—	—							
? Branconia, Cagel.				—							
Fam. Eichwaldiidæ.		—	—								
Eichwaldia, Billings.		—	—								
Fam. Atrypidæ.		—	—	—							
Subfam Zygospirinæ.		—	—	—							
Zygospira, Hall.		—									
Glassia, Davidson.			—								
Cœlospira, Hall.			—	—							
Anoplotheca, Sandberger.				—							
Subfam. Atrypinæ.			—	—							
Atrypa, Dalman.			—	—							
Grunewaldtia, Tschernyschew.				—							
? Karpinskya, Tsch.				—							
Fam. Spiriferidæ.			—	—	—	—	—				
Subfam. Suessiinæ.			—	—	—	—	—				
Cyrtina, Davidson.				—	?	—					
Delthyris, Dalman.			—	—							
Spiriferina, d'Orbigny.					—	—	—				
Suessia, Deslongchamps.							—				
Mentzelia, Quenstedt.							—				
Subfam. Uncitinæ.				—							
Uncites, Defrance.				—							
Subfam. Trigonotretinæ.			—	—	—						
Cyrtia, Dalman.			—								
Syringothyris, Winchell.				?	—						
Martinia, McCoy.				—	—	?					
Martiniopsis, Waagen.					—	?					
Ambocœlia, Hall.				—							
Reticularia, McCoy.			—	—	—						
Spirifer, Sowerby.			—	—	—						
Fam. Nucleospiridæ.			—	—	—						
Davia, Davidson.			—								
Hindella. Davidson.			—								

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary	Recent.
Nucleospira, Hall.			—	—	?	?	The Triassic forms belong to other genera.				
Retzia, King.				—							
Rhynchospira, Hall.			—	—							
Trematospira, Hall.			—	—							
Eumetria, Hall.					—						
? Acambona, White.					—						
? Uncinella, Waagen.					—						
Fam. Athyridæ.			—	—	—	—					
Subfam. Athyrinæ.			—	—	—	—					
Meristina, Hall.			—								
Bifida, Davidson.				—							
Athyris, McCoy.				—	—	—					
Cleiothyris, King.					—	?					
Seminula, McCoy.					—						
Spirigerella, Waagen.					—						
Dioristella, Bittner.						—					
Amphitomella, Bittner.						—					
Plicigera, Bittner.						—					
Kayseria, Davidson.				—							
Diplospirella, Bittner.						—					
Pexidella, Bittner.						—					
Anisactinella, Bittner.						—					
Subfam. Meristellinæ.			—	—							
Meristella, Hall.				—							
Pentagonia, Cozzens.				—							
Charionella, Billings.				—							
Merista, Suess.			—	—							
? Clorinda, Barrande.			—								
Fam. Koninckinidæ.						—	—				
Koninckina, Suess.						—					
Amphiclina, Laube.						—					
Koninckella, M.-Chalmas.						—					
? Thecospira, Zugmeyer.						—	—				
? Amphiclinodonta, Bittner.						—					
Fam. Terebratulidæ.		—	—	—	—	—	—	—	—	—	—
Subfam. Centronellinæ.		—	—	—	—	—					
Hallina, Winchell and Schuchert.		—									
Rensselæria, Hall.				—							
Newberria, Hall.			—	—							
Meganteris, Suess.				—							
Centronella, Billings.				—							
Cryptonella, Hall.				—							
Juvavella, Bittner.						—					
Nucleatula (Zugmeyer), Bittner.						—					
? Notothyris, Waagen.					—						
Subfam. Stringocephalinæ.				—	—						
Stringocephalus, Defrance.				—							
? Cryptacanthia, White and St. John.					—						
Subfam. Terebratulinæ.					—	—	—	—	—	—	—
Dielasma, King.					—						
Dielasmina, Waagen.					—						
Terebratula, Llhwyd.				?	—	—	—	—	—		
Hemiptychina, Waagen.					—	—	—	—			
Rhætina, Waagen.						—					
Zugmeyeria, Waagen.						—					
Dictyothyris, Douville.							—	—			
Glossothyris, Douville.							—	—			

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Pygope, Link.							—	—			
? Propygope, Bittner.							—				
Liothyrina, Œhlert.										—	—
Terebratulina, d'Orbigny.							—	—	—	—	—
Eucalathus, F. and O.											—
Agulhasia, King.								—	—	—	—
Disculina, Deslongchamps.							—				
Fam. Dyscoliidæ.											—
Dyscolia, Fischer and Œhlert.											—
Fam. Terebratellidæ.							—	—	—	—	—
Subfam. Dallininæ.							—	—	—	—	—
Dallina, Beecher.											—
Macandrevia, King.											—
Eudesia, King.							—				
Lacqueus, Dall.											—
Ismenia, King.							—				
Kingina, Davidson.								—			
Lyra, Cumberland.							—	—			
Trigonosemus, Koenig.							—	—			
Flabellothyris, Deslongchamps.							—	—			
Zeilleria, Bayle.						—	—	—	—	—	
Fimbriothyris, Deslong.									—		
Ornithella, Deslong.							—	—			
Microthyris, Deslong.							—				
Aulacothyris, Douville.							—	—			
Camerothyris, Bittner.						—	—				
Epicyrta, Deslong.							—				
Cincta, Quenstedt.							—				
Antiptychina, Zittel.							—	—			
Plesiothyris, Douville.							—	—			
? Hynniphoria, Suess.						—	—				
? Cruratula, Bittner.											
? Orthoidea, Friren.							—				
Subfamily Platidiinæ.											—
Platidia, Costa.											—
Subfam. Megathyrinæ.							—	—	—	—	—
Megathyris, d'Orbigny.							—	—	—		
Cistella, Gray.								—	—	—	—
Zeliania, Moore.							—				
Gwynia, King.										—	—
Subfam. Magellaninæ.									—	—	—
Magellania, Bayle.										—	—
Neothyris, Douville.									—	—	—
Terebratella, d'Orbigny.							—	—	—	—	—
Coenothyris, Douville.							—				
Subfam. Magasinæ.								—	—	—	—
Magas, Sowerby.								—			
Bouchardia, Davidson.											—
Muhlfeldtia, Bayle.											—
Mannia, Dewalque.							?	—	—	—	—
Rhynchorina, Œhlert.								—		—	

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
?Rhynchora, Dalman.								—			
Subfam. Kraussininæ.											—
Kraussina, Davidson.											—
Megerlina, Deslongchamps.											—
Number of genera appearing in each system.	22	47	41	40	36	24	35	10	1	7	11
			186				72			21	
Genera occurring in a system.	22	51	63	71	51	32	45	32	14	16	27
Genera restricted to one system.	18	24	20	35	33	21	21	7	0	1	11
Number of genera derived from preceding systems.		4	23	29	15	7	9	20	13	11	16
Number of genera passing from one period to the next above it.							7			13	

[Palæontological Notes from Buchtel College, No. 3.]

A NEW COCCOSTEAN—COCCOSTEUS CUYAHOGÆ.

By E. W. Claypole, Akron, O.

Figs. 1 and 2.

The "Old Red Sandstone" of Scotland furnished Hugh Miller with the original fossils on which the name *Coccosteus* was placed, and for which his now classic description was drawn up. He recognized several species but these have since been reduced to two by merging several into his first and chief form *C. decipiens* which, with *C. minor*, comprises probably all that he discovered.

Since his time, however, others have been brought to light but as these are not all described from the same plate or part of the skeleton it is scarcely possible at present to correlate them.

The structure of the genus is however fairly well understood so that little doubt exists concerning the position and relation of the various plates of the head and body. But of a few minor features and of the difference between the species in matters of detail much yet remains to be learned.